Computer Mediated Social Network Approach to Software Support and Maintenance

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Student Paper

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14. ABSTRACT
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Abstract

This research highlights the preliminary findings on the potential of computer mediated social networks. This research focused on social networks as an alternative method for support and maintenance of software intensive systems. The activities of the members of the discipline have impacted the support and maintenance practice. The computer mediated social network has attributes of a decision support system and other organized activities, but the potential is unknown and unmeasured. Our research provided empirical evidence that is a first step in defining the behavior and potential of a social network.

Introduction

The advent of the internet has created an unprecedented level of connectivity. This connectivity is being used to unite and synchronize the activities of the information professionals. The community of information professionals are currently engaged a monumental problem: how to provide efficient and effective support to software and software intensive systems. The cost of support and maintenance is escalating at an unchecked rate, and the current approaches and best business practices are not controlling or managing the problem. In response to this growing dilemma, a community of information professionals developed a self-managing process that is challenging the current common sense approach to support and maintenance of software and software intensive systems.

Social networks has become a buzzword used synonymously with social media like Facebook, LinkedIn, MySpace and other sites that allow individuals to socialize virtually with avatars like SecondLife and Sims. We use the term social network in the traditional sense of people connecting and the observable behavior and output generated from the connections (Granovetter, 1973; 1983; Milgram, 1967; Vega-Redondo, 2007). Computer mediated social network approach is a juxtaposition of the means, the actors and actions, and the discipline.

Our dependence on software has made the expenditures a necessity. The necessity is forcing individuals and organizations to allocate a larger percentage of their budget for support and maintenance of software intensive systems. A branch of the US government (USG), the US Army, has acknowledged that the current practice is unsustainable and that a significant change must occur. The change is necessary in order avoid the looming decision to fund weapon systems and warfighting capabilities or to fund the support and maintenance of software. The decision may appear obvious, fund weapon systems and warfighting capabilities, but the reality is that our weapons and command, control, communication, computer and intelligence (C4I) systems are software driven.

The high cost of software support and maintenance is a symptom of a larger problem. The larger problem is the inherent complexity of software and the software development environment. Cost, schedule, and scope are the benchmarks used to measure whether software development teams are

achieving their objectives. Disproportionate amount of time and effort is allocated to the pre-development and development phases of the software lifecycle when we consider where most costs of software are realized: the post-development phase. The most skilled software develop team will deliver a software product that requires support and maintenance from day one and at a price tag that, over the software's lifespan, will exceed the total cost of the development and the hardware combined (Boehm, 1976 cited in Endres & Rombach, 2003; Grubb & Takang, 2007).

This research is not about motivation; instead this research focuses on the effectiveness and efficiency of this process, as compared to the other established support and maintenance practices. The methods that software engineers use to share knowledge are beginning to emerge and develop its own stream of research within the development communities (Shaw, 2009; Bosch, 2010 unpublished). Our research focused on a phase of software lifecycle, the costly post development activities of support and maintenance.

This research validated whether or not a computer mediated social network approach software support and maintenance can provide a viable alternative to the current approach to software support and maintenance. The current approach is unsustainable. Ultra large scale organizations are realizing that the current approach is not only affecting the bottom line; it is also impacting the operations of the organization. If an alternative exists that can provide quality results at lower cost, then the environment of software support and maintenance may evolve into a new and sustainable paradigm. What is clear is that a change is needed to control the escalating cost of software support and maintenance is unsustainable.

The term social network has become a buzzword used synonymously for social media like Facebook, LinkedIn, MySpace and other sites that allow individuals to socialize virtually with avatars like SecondLife and Sims. We use the term social network in the traditional sense of people connecting and the observable behavior and output generated from the connections (Granovetter, 1973; 1983; Milgram, 1967; Vega-Redondo, 2007). Computer mediated social network approach software support and maintenance is a juxtaposition of the means, the actors and actions, and the discipline and can be described as a self-organized, self-sustained, emergent, ad hoc decision support system.

Hypothesis

In our academic inquiry, we explored three hypotheses to compare the emergent self-organized activity to the published practices of software and software intensive system support and maintenance. There is little empirical evidence to support or refute the idea that an emergent decision support system can improve the support and maintenance phase of the software lifecycle (SLC). This research provided empirical evidence on how the emergent process impacts the support and maintenance phase of the SLC in an ultra large scale organization and its information system infrastructure. To accomplish the task, three fundamental questions were addressed in the form of hypotheses.

H_1: The ad hoc emergent decision support system will result in faster responses to maintenance problems than the traditional maintenance processes.

H_2: The ad hoc emergent decision support system will result in higher (quantity) transfer of knowledge (actionable information that is accurate and has utility) than the traditional maintenance processes.

H_3: The ad hoc emergent decision support system and infrastructure requires less effort (more efficient) compared to published support and maintenance process.

The data necessary to conduct this inquiry was collected from a community of informants who operate in the post development phase and associated with the USG's automated information infrastructure. We described the phenomena of a community that shares and exchanges knowledge and experience about the domain of support and maintenance. The informants communicate via a computer mediated

social network that evolved into a human in the loop decision support system and an electronic network of practice.

Methodology

Our research utilized a mixed method approach to examine a case study that includes archival and network analysis, interviews, and surveys to examine the behavior and activity of the community of informants. The case study research methodology included qualitative and quantitative data. The case study research methodology was appropriate because our desire was to understand complex social phenomena (Yin, 2003) and acquire new knowledge regarding the behavior and activities of a group. This method fits the exploratory nature of research; the subject is not tightly configured or restricted to *a priori* statements. The concept of emergence and letting the data speak for itself are highly regarded research methods in multiple disciplines (Glaser & Strauss, 1967; Strauss & Corbin, 1990) that seek understanding without preconceptions that may taint the research. We used a quantitative approach to analyze the archived data. Our quantitative approach is one that was primarily used to make post-positivist claims regarding the data to gain understanding about a phenomenon (Creswell, 2003). The idea that the truth is available and waiting to be measured, presumes that this research method is geared towards discovery, and it was.

Background

The paradox of software is that the more we learn about the software and gain experience with the product, the higher the cost to support and maintain the software (Blum, 1985). Blum's observations are consistent with Lehman's law that asserts that software is continuously evolving and increasing in complexity (Endres & Rombach, 2006) making it more difficult maintain. A gap exists between what a support and maintenance team knows and what they need to know; this gap widens over time.

Software is not static; it is in constant state of change. As software changes it becomes more complex (Figure 1). Change is rooted in multiple factors. From a development perspective, change is driven by requirements, operating environment and/or the desire to improve the software. From a post development perspective, change is driven by system updates such as application updates, information assurance vulnerability alerts (IAVA) and new or previously undisclosed requirements. Change and complexity are entangled in a reinforcing loop (Figure 1) and efforts to reduce the complexity and fill the knowledge gap are contributing to the high cost of support and maintenance. Alternatives to the current common sense need to be explored.

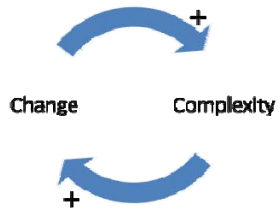

Figure 1 Reinforcing loop – Lehman's Law on change and complexity

This research focused on an alternative method for support and maintenance of software intensive systems. The alternative method has emerged from the community of information professionals and practitioners who are responsible for the support and maintenance of software intensive systems. The group used computer mediated communications to actively share their knowledge and experience. The injection of knowledge and experience in the change and complexity cycle created a balancing loop

(Figure 2). The activity of the information professionals and practitioners community had an impact on the support and maintenance domain.

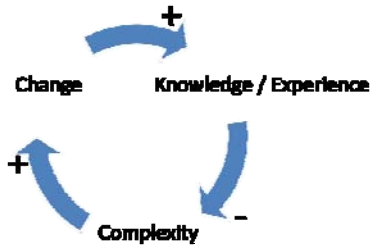

Figure 2 Balancing loop- Lehman's Law with knowledge and experience

The phenomenon is an emergent, ad hoc decision support system that has self organized into a valuable tool for the community. The decision support system is a social network as well an electronic network of practice (ENP), a computer mediated subset of a community of practice (McLure-Wasko & Faraj, 2005). The emergent method has the components of the traditional archetype decision support system, which includes users, a system, an interface, a knowledge base, and a process (Marakas, 1999) as well as attributes of a social network where the connectedness to others pays dividends (Granovetter, 1973; 1983) in the form of actionable information. The potential of a decision support system built around a social network is unknown and unmeasured in computer mediated environment.

What is unique about this ad hoc system is that it is a human-in-loop process, which has self-organized with socially constructed rules. In this system, members (users) use a network and simple email (system and interface) to actively exchange knowledge (knowledge base) and provide (process) a service to the general membership. No one controls the dialogue or moderates the activity. This process is impacting how support and maintenance is practiced. The impact is twofold. First, information professional are turning to this mechanism for answers and to gain understanding regarding the challenges to the community. Second, the service and output provided was responsive and free. Information professionals were willing to share their knowledge with a community of peers for no monetary exchange.

The study of networks is in a renaissance. The renaissance focused on the potential of social networks. The potential and meaning behind a network pre dates computers and the associated disciplines. Networks, connectivity, and changes in social behaviors have a following in mathematics (Euler, 1741; Sachs, Stiebitz, & Wilson, 1988), philosophy (Durkheim, 2001), the social science domain (Granovetter 1973; 1983; Milgram, 1967; Vega-Redondo, 2007). Savvy and observant professionals have exploited the potential that exist when a community is organized and provided a vision, direction, or common focus (Senge, 1994; Senge, et.al., 1994; Wenger, 1999; Wenger, McDermontt, & Synder, 2002). Computer mediated communications are facilitating a renewed resurgence of interest in networking by lowering barriers to communication, making links transparent, nodes ubiquitous, and bridging people and their knowledge at an unprecedented scale.

Software Support and Maintenance Quagmire

Software maintenance and support is in a quagmire. The level of effort required by the people to maintain and support software intensive systems is reflected in the cost. The cost to maintain and support software intensive systems exceed the total cost of the hardware and software development combined and is measured in billion dollar units (Boehm, 1976), and it is growing. The longer a system is in development and in use, the greater the cost to support and maintain the system (Lehman, 1980). There is no foreseeable end state to the quagmire.

The current best business practice for support and maintenance is a hierarchal/tiered approach. This approach distributes people throughout the domain where software intensive systems operate. From the battlefield to the classroom to the boardroom, maintainers operate everywhere there is a system and at every echelon of responsibility and leadership. The support infrastructure and best business practices are costly and they are disjoint. While the infrastructure provides support, it also rations assistance. The rationing contributes to delays and dissatisfaction in the process.

Software post development

Our study examined the software post development phase of the software lifecycle. This phase is where support and maintenance occurs. There are three phases in the software development lifecycle that broadly define the activities and stage of production: predevelopment, development, and post development (Figure 3). There are multiple activities (e.g. operations, support, maintenance, production, and in-use) that occur in the post development phase. The activities are uniquely defined by various software development methodologies. We generalized these activities as maintenance and use the term as an all encompassing action. Maintenance occurs in the post development phase of the software life cycle (Figure 3).

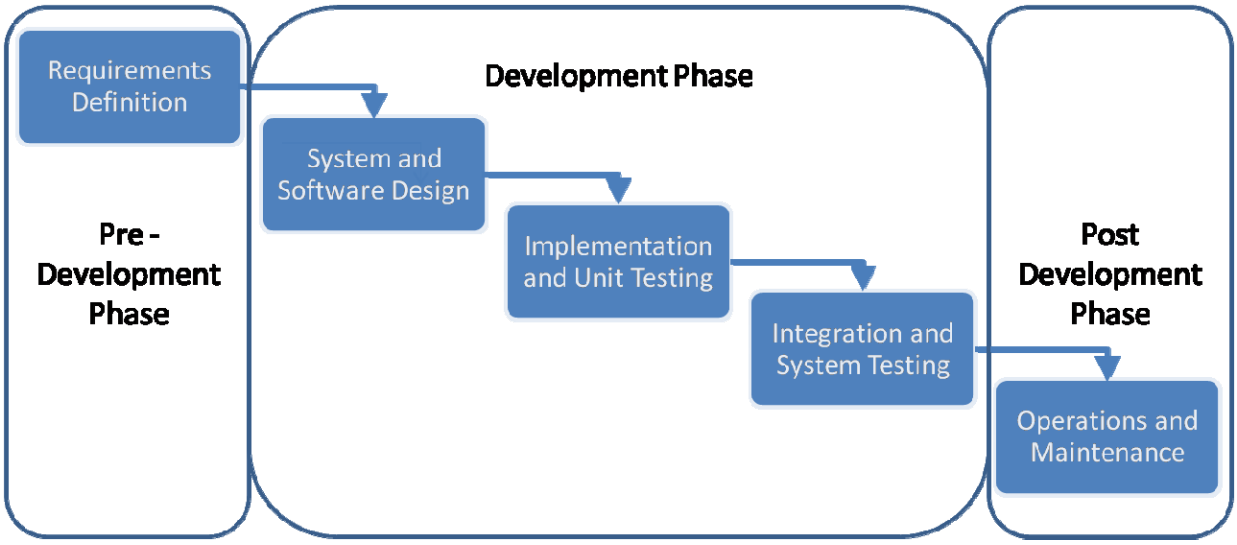

Figure 3 Software development lifecycle overlaying the waterfall methodology

Information professionals work in an environment where incomplete information is widespread (Grubb & Takang, 2007). Due to the lack of, incomplete, or outdated documentation and operating procedures, information professionals must be part historian, part detective, and part clairvoyant (Corbi, T.A., 1989) in order to understand to perform proper maintenance. Incomplete knowledge, longevity of software, and organizational structures and processes are contributing to the complexity and cost of the domain (Endres & Rombach, 2003; Lehman, 1980; Grubb & Takang, 2007). The post development community of information professionals is using a computer mediated social network to fill the void between the knowledge needed and the knowledge available to accomplish their tasks.

Organizational Reaction to the quagmire

The Department of Defense (DoD) realized that the current practice is failing to control the activities and the cost of system support and maintenance. If the support and maintenance activities remain unchecked, the cost will approach a tipping point that will have implications on which weapon systems will fight our next wars, and what life saving gear will not be procured. The DoD's dependency on software intensive system has made the cost of maintenance and support a necessary expenditure, with a higher priority than some future weapons system.

While the cost of the system may be a onetime expenditure, the cost to maintain and support a system is unknown, illusive, and/or difficult to quantify. It is unknown or unclear because the maintenance and support activities are spread to multiple echelons of a disjoint support infrastructure. Software maintenance and support infrastructure consists of multiple organizations, divisions, and sections and countless personnel that support an unknown number of systems. The scope and size of the problem is unknown. In a recent memorandum, the US Army Chief Information Officer and Military Deputy for Budget Assistant Secretary of the Army (April, 2010) issued a directive to gather the necessary information to identify the number of systems that operate on the US Army network in order to control costs. Identifying the scope of the problem is no simple task and requires executive level directives to gain control of the problem.

Current Practice and Operating Environment

The maintenance and support infrastructure sustains a service culture where people and their knowledge and know-how are the commodities that are being exchanged. The current mechanism of exchanging commodities is a tiered and filtered process (Figure 4). The mechanism aggravates the problem. By design, the smartest people are being separated from the problems they are supposed to be fixing and the least experienced people are the interface with end users (Lientz & Swanson, 1980).

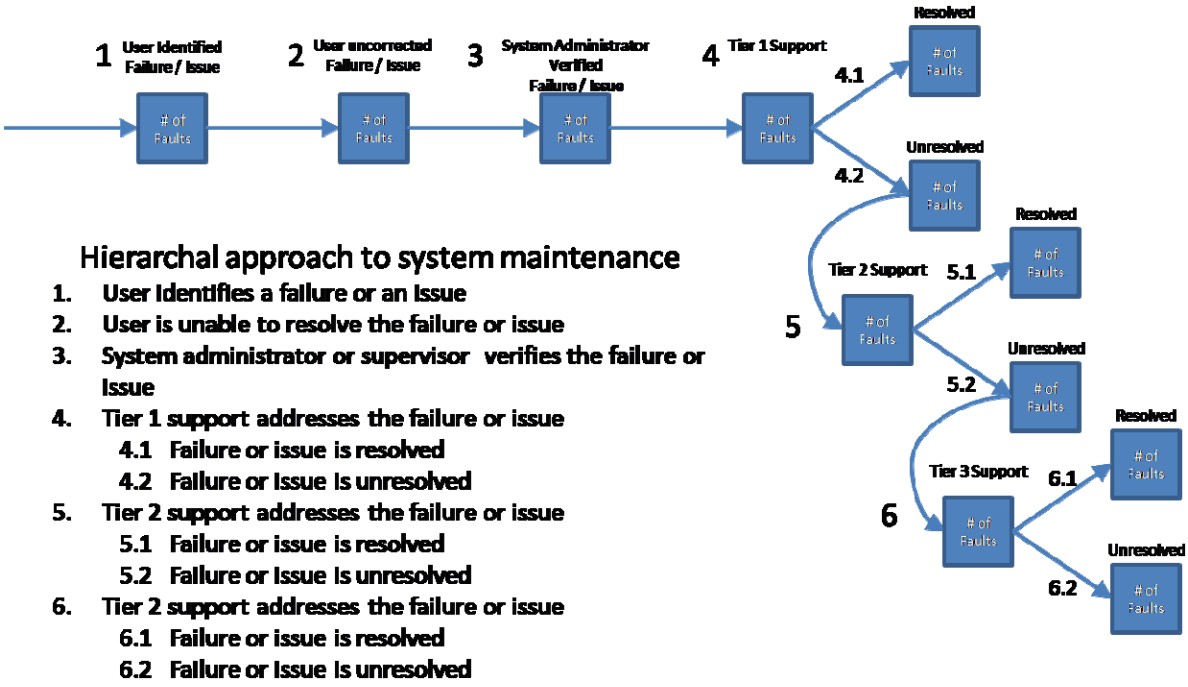

Figure 4 Tiered and filtered approach

We understand the following to be true. Maintenance and support of software intensive systems is resource intensive; manpower that is manifested in dollars. Software intensive systems will be delivered with faults; no system is perfect. The current sluggish acquisition process is not responsive to validation and verification issues that relate to a dynamic operating environment; needs and expectations change faster than the process can accommodate. Lastly, the current support infrastructure is harming as much as it may be helping by separating those who know the answers from those who need the answers. This understanding has manifested in the current maintenance quagmire.

A New Common Sense

The need to share versus the need to know is one of the characteristics of the phenomenon that has emerged in the software support and maintenance community. The new common sense has emerged out of necessity. It is a community approach where practitioners and professionals gather to share

ideas, thoughts, problems, and solutions. The community approach flattens the hierarchal structure (Figure 4) of the tiered approach and includes administrative support and the leadership in the process of problem resolution.

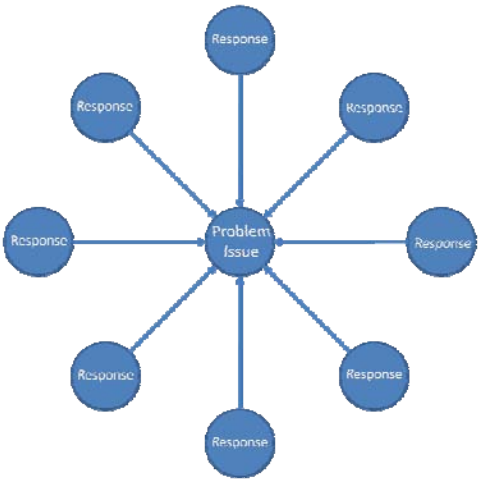

Figure 5 Flattened structure focused on the problem or issue

In the flattened structure, many of the elements or nodes who are part of the tiered or hierarchal approach are present in the flattened structure. Technicians and managers are intermingled, with no or little regard to position or authority that exists outside the domain. Senior executives (CIO's, CTO's, Program managers) participate in the discourse with rank and file members.

The Community of informants

The informants for this research were members of an ad hoc group consisting of a fluctuating membership that has averaged about 1,000 for more than 10 years. The stratification of the members includes recognized senior leaders of their respective organizations (e.g. DoD and private industry), experts (recognized and emergent), novices and everything in-between. The members are information professionals who represent themselves and are members of a multitude of US Department of Defense agencies, other government agencies, private industry, and public & private ventures. The common interest of group is support and maintenance of the DoD's information infrastructure. The group serves as a support system and knowledge base for information professionals.

Summary of preliminary finding

This multidisciplinary research provides several contributions. From a software engineering perspective, this research provided insight into the behavior of practitioners who operate in a dynamic post development environment and how they are used collaborative methods to address the maintenance quagmire. From a social science perspective, we describe the ethnography of the group and the observable patterns of behavior that emerged from the computer mediated social network. Lastly, from an information science perspective we detail how information and knowledge was shared. From the coalescing of these discoveries we develop a benchmark of performance for computer mediated social networks.

- **ROI**: The return on investment (time saved / time invested) was significant; time savings averaged over 1,000 % when respondents report savings in hours (less than a day) and 28,000% when savings are reported in days.
- **Knowledge seeking**: Information seeking patterns are evolving from searching knowledge databases (knowledge that has been articulated, saved, and made available for consumption) to

connecting with expert services (experts and their knowledge) via computer mediated social networks as a primary means to resolve problems.

- **Expert knowledge**: Expert Knowledge is the primary knowledge that is exchanged in computer mediated social networks.
- **Reducing complexity**: This research identified that information seekers have a high probability of reducing the difficulty of their problem to a simple problem; Category II problems have a 72% likelihood of being reduced to a Category I problem and Category III have problems 79% likelihood of being reduced to a Category I or II (see Appendix A, Table 1 in H_2 supporting data).
- **Benchmarks of Performance**: This research indentified response rates on several dimensions, from time to response to number of responses that can be used to establish baselines or benchmarks to measure the performance of other computer mediated social networks.
- **Ethnography**: This research indentified patterns of behavior that inform the ethnography of the group; demographics, education and training, motivation for participating, and their philosophy for sharing.

Hypotheses summary

H_1: **The ad hoc emergent decision support system will result in faster responses to maintenance problems than the traditional maintenance processes.**

Finding: H_1 was validated, the response time and time to resolution was significantly faster than alternatives

Discussion: We examined how a self organized and self sustained social network (community of practice) manages to circumnavigate the established protocols and determine the effectiveness of their process.

We examined how service providers seek assistance through a network of information professionals and used their [1] practice and feedback as our sources of comparison. Current practices focused on the time invested by service provider, not the information seeker. This research focused on higher than tier 1 assistance. There are several practices and tools to capture time invested and time saved used by multiple service providers (e.g. Remedy IT Service Management tools, Earned Value Management), but our research discovered that the tools are not utilized correctly as reported by our sources and the tools do not capture the difficulty level of problems, or they focused on cost to the service providers. The statistics provided by service providers were misleading because the majority of the reported problems were simple (i.e. password reset) and repetitive problems. When the established processes failed to provide an answer or a means to resolve an issue the information professionals turn to the alternative. The alternatives are not documented. One of the alternative processes was a computer mediated social network. The social network approach augmented the established procedures.

Contribution: This research validates that a social network (community of practice) approach to maintenance has value and demonstrated that it is significantly faster (across all time zones) than the traditional maintenance process and suited to address more complex problems that require knowledge and/or experience. This is evident when the informants reported the time saved using this process versus other processes. This validates the belief that community generated knowledge process (e.g. open source, crowd sourcing) is effective when compared to alternatives and current business practices.

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[1] Consortium for Service Organizations
Army Workload and Performance System (AWPS) Enterprise Solutions Competency
C4ISR system information and reach-back for support
AKO/DKO Program Management Office

Methodology: We used archival analysis to separate information requests from all other transactions. We developed a simple return on investment formula based on time invested and reported time saved. Response times were determined from the archival analysis and compared to survey respondent data.

H_2: **The ad hoc emergent decision support system will result in higher (quantity) transfer of knowledge (actionable information that is accurate and has utility) than the traditional maintenance processes.**

Finding: H_2 is validated, the feedback process of the social network approach illicit expert assistance to address issue

Discussion: The social network approach process includes a feedback mechanism that contributed to the quantity and quality of the information provided. The traditional maintenance processes are point to point and tiered, where the audience and feedback was 1:1. The computer mediated social network approach used a broadcast method (Figure 6) that is one to many (information requestor : all subscribers to the broadcast). The responses can come from anyone in the network (Figure 7). The broadcast process of the social network allows for everyone in the network to view the problem and the responses.

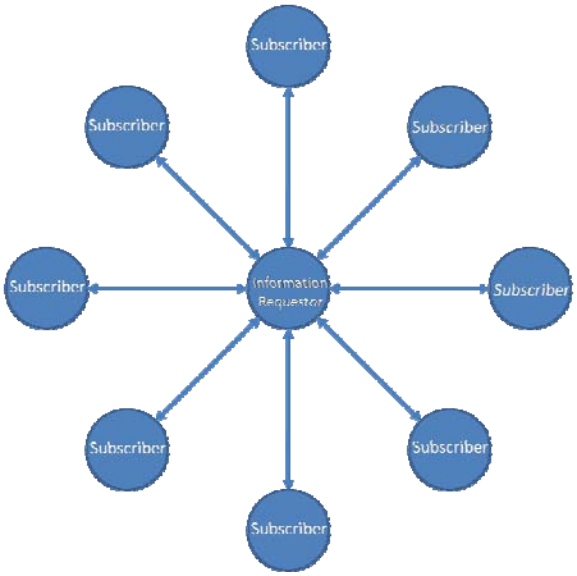

Figure 6 one to many

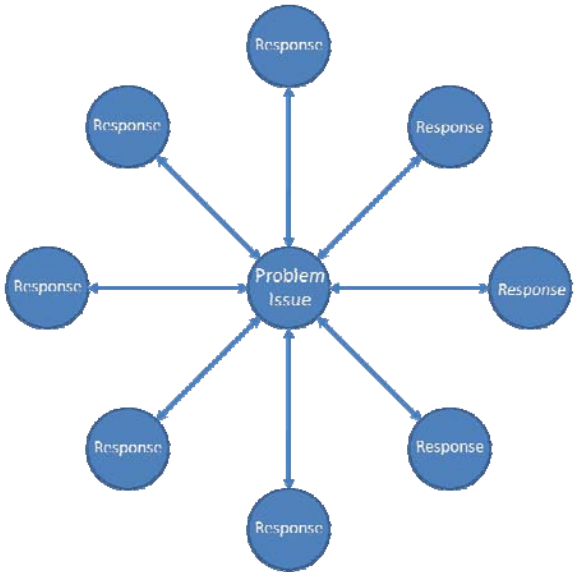

Figure 7 potential responses to a problem or issue

The practice of the social network is to self police the responses. If incorrect or incomplete information is provided, member of the community will promptly correct the behavior. The quality of the information provided is also an issue, because anyone within the group can respond. Validation is an issue as well. Online forums have a propensity to rate the usefulness of the response and the status (reputation, experience, volume, activity) of the information provider as part of the validation process. This social network relies on the process of feedback and correction. The process is proven to be effective in generating information and knowledge, but also in generating expert assistance.

Contribution: This research validates people are responsive to request for information, are influenced by the information provided. This research identified an emergent process of self correction that generates the necessary knowledge and expert assistance to resolve an issue. This research demonstrated the process of feedback in an open forum provides mechanism of validation that is responsive and self-correcting of incomplete and incorrect information. The computer mediated social

network created a shared awareness and understanding of the domain that is consistent with the ground truth.

Methodology: Archival analysis that determined the response rate for information requests (mean of 6) and compared to the informant reported rates of response (3-6). Survey informants reported the quality of the. The survey also queried for the quality of the information that was shared.

H_3: **The ad hoc emergent decision support system and infrastructure requires less effort (more efficient) compared to published support and maintenance process.**

Finding: H_3 was validated; the cost (measured in time) of maintaining the process and infrastructure was incidental and the cost to participate was low.

Discussion: The social network approach to maintenance is free in the sense of Robert Stallman's free speech and free beer. The infrastructure is a simple email server that includes access to the internet, a personal computer and readily available free software. The cost of the expert knowledge is spread over all the members of the community. On average the dialogue was read/reviewed regularly for only five to ten minutes. Information requestors and providers spent less than five minutes posting questions and less than 20 minutes researching and answering. The dialogue generated by the members captured the question, answers, and supporting contextual information that framed the environment of the question. While knowledge is generated, the information is stored for future use. Archiving was a byproduct. We identified the behavior patterns of an active group that has been in existence since 1998. We were also able to describe the ethnography of the group and identify that the value transcends all demographics of a community.

Contribution: We observed a shift in knowledge seeking behavior from data centric to people centric search methods. This finding is significant because a computer mediated social network made the process simple (low level of effort) and the cost of the infrastructure to support the process was insignificant. The sharing of a problem and solution with a wide audience is changing how complex problems are solved. By using a community generated mechanism to generate knowledge all participant benefit from the dialogue and individuals were empowered to act by contributing to dialogue.

Methodology: Interviews with the owners of the infrastructure provided the cost data and level of effort. Archival analysis allowed us to determine the frequency of postings (how often individuals post). Survey data revealed usage patterns of behavior and demographics of the group.

Discussion

The process is remarkably simple, requests for information (RFI) are broadcast (pushed) to all members to view and potentially respond to. Every member of the community subscribes to the broadcast via email. When a member has a problem or issue, he submits the problem or issue to the group for review and comment (See Figure 8 and Appendix B). The process repeated as feedback was provided.

The feedback process is demonstrated in figure 8. Step 1 is the identification of a problem or issue. The problem or issue becomes an artifact in the network for all to observe. Step 2 is the generation of responses to the problem or issue. Feedback is (step 3) to the original RFI/information seeker was generated. If the feedback was sufficient, the process stopped. If not, then original RFI/information seeker may provide additional information or respond to the feedback (Step 4). The community then responds to new information (Step 5). This process is asynchronous; individuals provide feedback while simultaneously updating the (Step 7) discussion thread, while others respond (Step 8) to the originally posted problem. Having more than one course of action on one discussion thread enabled the

community to collectively brainstorm several viable options.

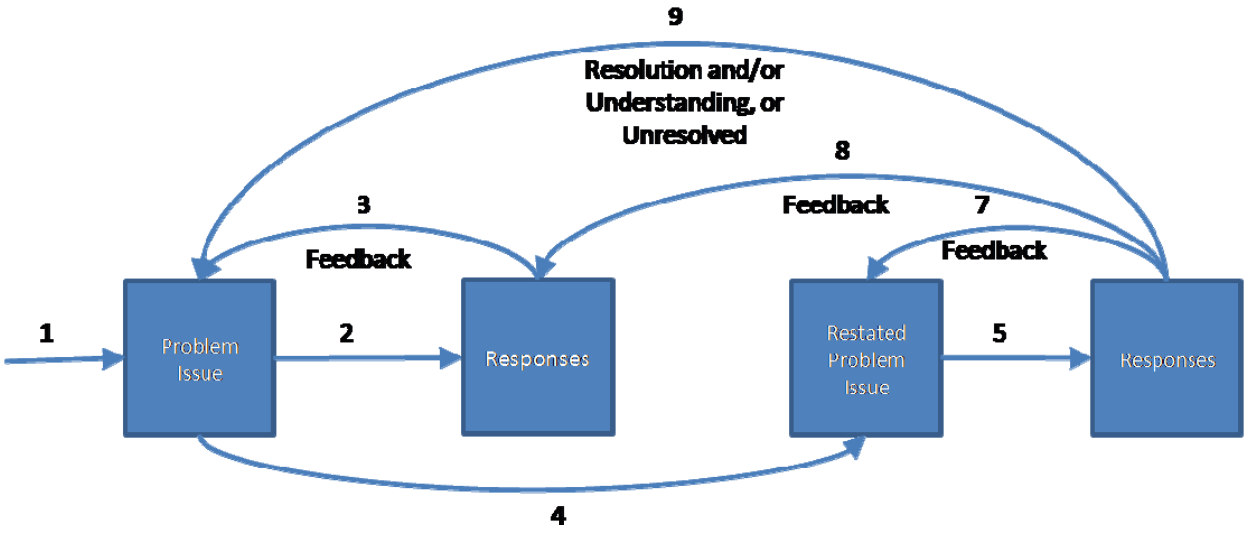

Figure 8

An example of an actual exchange is depicted in figure 9. Note the feedback loops. The feedback loops are responses that validated, corrected, improved, or clarified the previous comments. In figure 9 the information requestor is having a problem with the performance of a specific search engine. Responses 1, 2, 5, and 12 offered unique solutions or courses of action. Response thread 6 (R6) validated the problem to the community and Response 7 offered a fifth solution to R6. R6's problem was similar, but a slightly different problem. Response 11 clarified the uniqueness (differences) of the problem and presented the solution to R6. The end state for the community was robust exchange of knowledge that occurred over three working days, by a worldwide community. The phenomenon is not unique. This is typical behavior for the group.

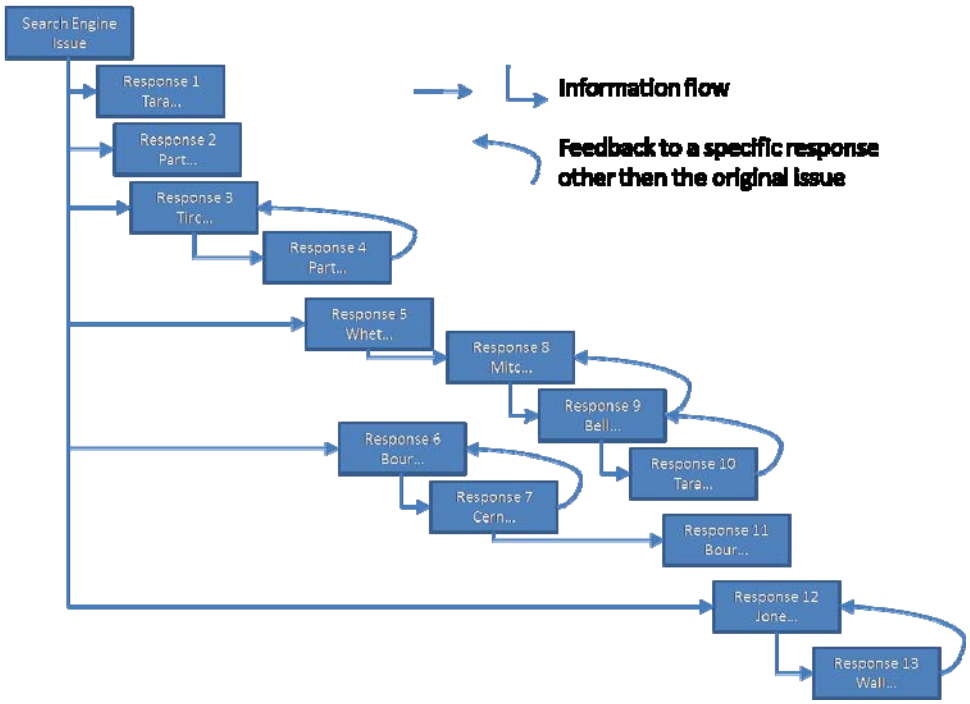

Figure 9

The connectivity between the members of the group is what enabled such a robust dialogue. What was enabled by connectivity has been the subject of numerous threads of research in multiple domains. From social behaviors and mathematics (Euler, 1741; Sachs, Stiebitz, & Wilson, 1988), to philosophy (Durkheim, 2001), to the strength of the connections a (Granovetter 1973; Granovetter, 1983) and the number of connections (Milgram, 1967; Vega-Redondo, 2007). Connectivity enabled a fundamental shift on how and where people seek knowledge and know-how to resolve their problems. Information technology has created communication channels that as connecting physically, culturally, and socially disparate entities. This had an effect on the software support and maintenance practice.

Connectivity enabled the social phenomenon. Individuals and groups came together and transcended social behavior in a computer mediated domain. From rudimentary computer bulletin boards developed in the late 1970's to more elaborate virtual worlds like Second Life, and FaceBook; individuals were bridged together with the assistance of technology and computer mediated communication. The domain is a virtual place, but not separate from the physical and transcending social and organizational boundaries (real and perceived).

It is overly simplistic to define this domain as only virtual: being a simulated existence or manifestation existing only online (Wehmeier, 2003; Bound, 2003). The virtual domain exists in cyberspace and includes the physical domain. The DoD has a more encompassing definition of this domain; it is called the global information grid (GIG). The GIG is the globally interconnected, end-to-end set of information capabilities, associated processes and includes the human element (Joint Chiefs of Staff, 2006; Joint Chiefs of Staff, 2007) that enables and orchestrate the myriad of activities associated with the information handling and processing.

High profile cases of community sourced knowledge demonstrate the potential of this phenomenon. Exemplars, like Wikipedia, InnoCentive and the Open Source development projects, have demonstrate that the phenomenon can produce results (Gallivan, 2001; Raymond, 2001; Tapscott & Williams 2008), but the rate of success is not clear for all activities in a domain. Examinations often fail to include the unreported failed projects, the projects that never started, the unanswered questions, or incorrect responses (C. Gunderson, personal communication, March 12, 2009). Other behaviors are underexplored, such as the responsiveness of the community, the quality of the response, and the willingness for people to share their expertise and know-how (Smith, 2001; McLure-Wasko & Faraj, 2005). This research addressed the effectiveness of the method and the efficiency of the process.

Change is the one constant in software and software intensive systems in a post development environment. Maintainers have adapted by sharing the knowledge by means other than published procedures. Published maintenance procedures are becoming less common, because the environment is making published material obsolete before they can be distributed.

The adaptation of behavior in a social technical environment is evident and manifesting in computer mediated social networks. What we highlighted was the effectiveness of the process of mass collaboration had on system maintenance domain. The sharing of personal and professional experiences through computer mediated social networks is a phenomenon that can be measured.

Conclusion

Our research examined a social network approach to software support and maintenance in the post development phase of the software life cycle. The activity can be labeled collaborative, community sourced knowledge, or other buzz words. We provided benchmarks for performance and demonstrated that the social network approach is a viable alternative to current common sense approaches.

System maintenance, like the effectiveness of computer mediated collaborative process, is notoriously difficult to measure due to the complexity of the activities and the behavior of the individuals in the domain (Grubb & Takang, 2007; Lientz & Swanson, 1980). System maintenance is the often overlooked discipline of the software life cycle (Glass & Noiseux, 1981). We conducted exploratory research to identify how and if a community of information professionals was benefiting from computer mediated social interaction in order to generate knowledge. We found the community is not only benefiting, but the behavior is changing to take advantage of the computer mediated social network.

This emergent process is not without risk. The focus of the community is not explicitly defined and no one person or group guides or facilitates the behavior of the members. Participation is voluntary and there is no defined vetting of the quality of the dialogue. In spite of the potential of receiving bad information with no recourse; information professionals continue to come and share their knowledge and experience with other members of the domain. The rewards, at face value, appear to be outweighing the risks.

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Appendix A
Supporting Data

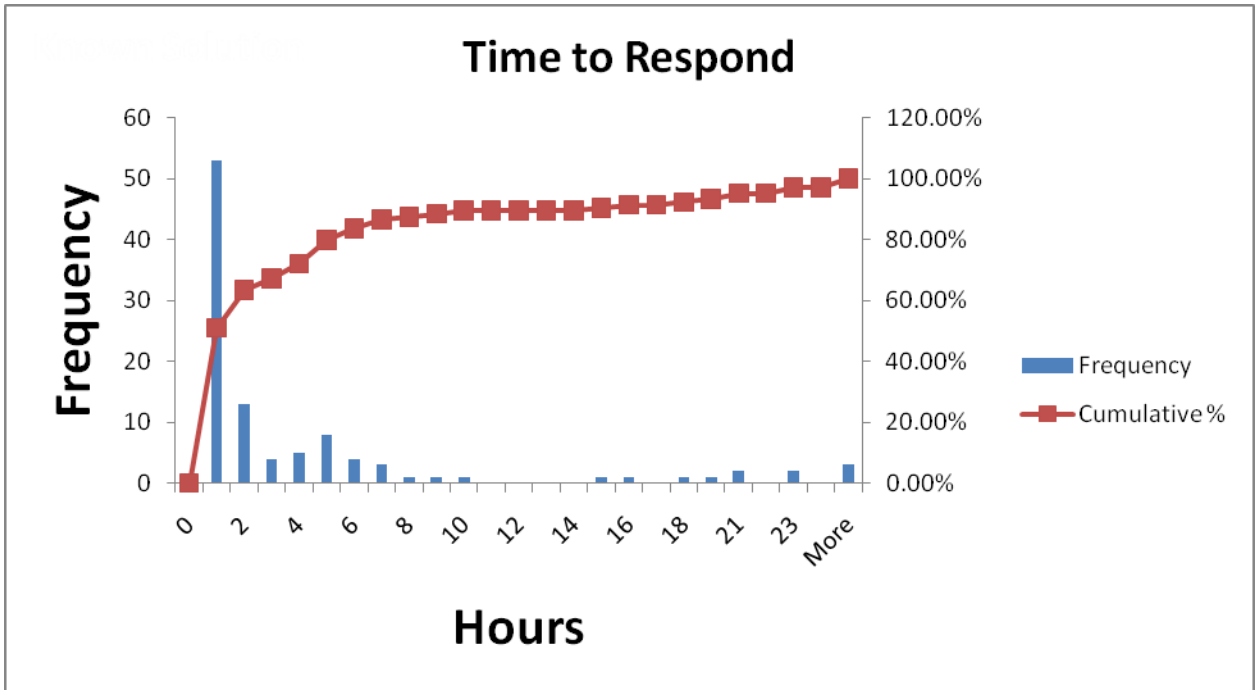
H_1 Supporting data:

1. Return on investments (ROI) is significant
   - > 30 Minutes Average time spent researching a problem prior to using the computer mediated social network
   - < 5 minutes Time to query the social network (TQySN)
   - ROI (TS/TQySN) Reported time savings (TS) % of information seekers

     3600% 3 – 4 hours saved (3 hours / 5 min) 38% (those who reported in hours)

     22,800% 1 – 2 days saved (24 hours / 5 min) 77% (those who reported in days)

2. This research indentified response rates on several dimensions, from time to response to number of responses that can be used to establish baselines or benchmarks to measure the performance of other computer mediated social networks.
   - Discussion: Finding: Response rate measured in time and quantity (Appendix A, Figure 1).
     - Time:
       - 1 hour 50 % of all threads receive a reply within 1 hour
       - 2 to 4 hours 72 % response time for all treads (cumulative)
       - 5 to 10 hours 89 % response time for all treads (cumulative)



Appendix A, Figure 1

3. This research identified that information seekers have a high probability of reducing the difficulty of their problem to a simple problem; Category II problems have a 72% likelihood of

being reduced to a Category I problem and Category III have problems 79% likelihood of being reduced to a Category I or II.

a.

Category of Problems	Known Solutions	Unknown Solutions
Known Problems	Category I	Category II
Unknown Problems	Category III	Category IV

Appendix A, Table 1

b. Finding Measures of quality of response

1. Category II problem 72 % satisfaction rate of information seekers
2. Category III problem 79 % satisfaction rate of information seekers

H_2: Supporting data

- Number of response from archival analysis (reported from survey)
  - Mean 6 (3-6)
  - Median 3.5
  - Mode 1
  - No online response rate 35% (0)
- Reported response rate from members
  - Online (broadcast) 54% reported 3 - 6 responses to questions
    30% reported 7 - 10 responses to question
  - Offline (point to point) 30% reported 1 - 2 responses to questions
    25% reported 3 - 6 responses to question
- Quality of the information provided
  - Information requestor
    - 77% report receiving expert assistance
  - Information providers
    - 84% report giving expert assistance
- Completeness of answers reported by those providing answers
  - Full solution……..18%
  - Knew where to find a solution…….18%
  - Some useful information……49%
- Completeness of answers reported by community
  - Enough relevant information was provided
    - To solve problems……79%
    - To understand the problem…77%
    - Implement a solution……53%
- Faith in the process and the members of the domain
  - Correct and believable information is provided
    - 66% agree that correct answers are provide
    - 54% agree that believable information is provided
    - 63% agree that information provided is consistent with the ground truth
  - Informants report that the self correcting process validates or verifies…
    - 79% Incorrect answers (correct misinformation)
    - 71% untrustworthy information (correct untrustworthy information)
  - 53% of informants believe that good answers exist even if they don't provide one.
  - 74% report being an expert in one or more part of the domain.
  - Representative sectors development

        - 14% pre development
        - 22% Development
        - 64% Post Development
    - Representative industry (multiple categories)
        - 16% Service provider for a specific product
        - 34% policy making
        - 39% general support
- Influence on the membership
    - Information provided caused members to re-evaluate their positions
        - 71%
    - Information provided affected the members decision on a course of action
        - ***71%***

H_3: Supporting data

Cost to manage the information system the supports community. Trivial as reported by the list founders and current custodians of the system.

Behavior and Usage patterns

- How often do people read the traffic on the list and how much time do you spend reading?

			<5 min	5-10	11-20	21-30	>30
• Daily		72%	**18%**	**46%**	**26%**	**10%**	1%
• Weekly	18%	10%	**47%**	26%	12%	6%	
• Every two weeks		3%	0	67%	33%	0	0
• Monthly or more		3%	25%	13%	38%	0	25%

- Other options, but not significant

  BOLD makes up 80% of the informants

- Search patterns

Percentage selected as the 1st option	Sources (Respondents had up to 5 choices)
29 %	53 Lists (message threads, archives, or contacts)
21%	Search Engines (e.g. the Internet, Google, Bing)
8%	Co-worker
7%	Books or other printed material
6%	Internal organizational support (e.g. help desk)
6%	Vendor provided resource
5%	External organizational support (regional help desk, program manager)
2%	Embedded assistance (software help function)

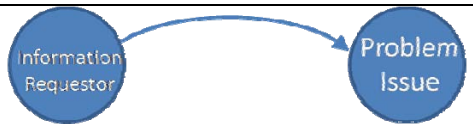
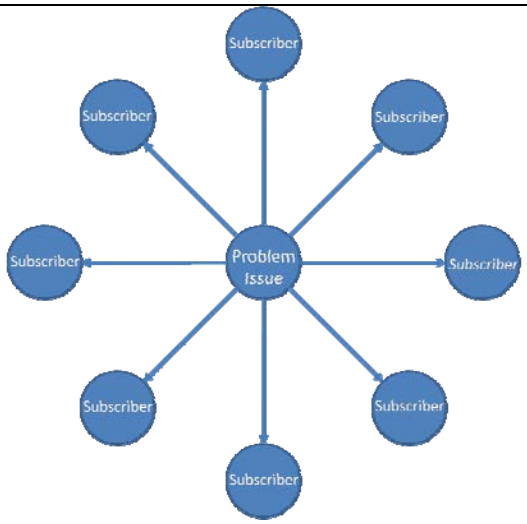
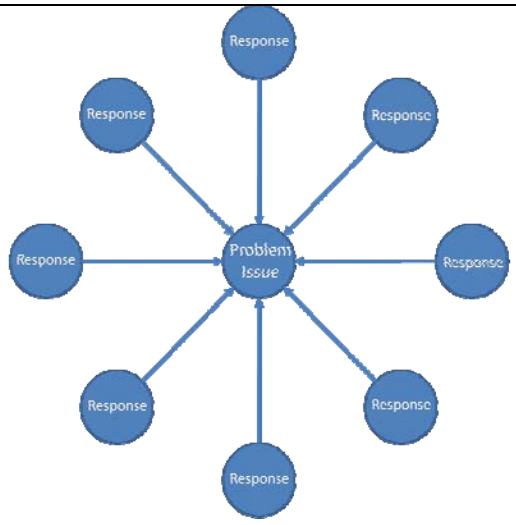
Appendix A, Figure 2

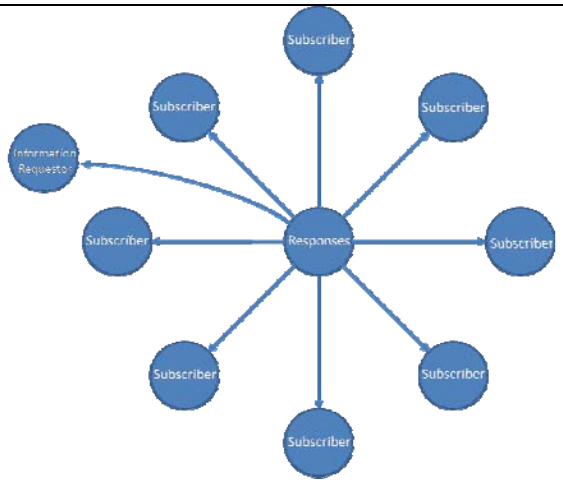
Demographics of the community

Answer Options	Response Percent	Response Count
Executive	4.1%	11
Senior Supervisor, Manager . . .	20.1%	54
Senior Professional/Analytical. . .	7.1%	19
Senior Scientific, Engineering . . .	12.7%	34
Mid Level Supervisor, Manager. . .	24.3%	65
Middle Professional/Analytical. . .	5.6%	15
Mid Level Scientific, Engineering,	11.6%	31
Junior Supervisor, Manager . . .	1.1%	3

Appendix A, Figure 3

Appendix B

Step 1: A member identifies an problem or issue and submits a RFI to the community email Listserv	
Step 2: The problem or issue is broadcast to all members/subscribers to the Listserv	
Step 3: Members review and decide whether or not to respond to the RFI.	

Step 4: The original requestor of information as well as the rest of the community receives feedback from those who responded.	

Appendix B, Table 1